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# Pronoun Processing in Aphasia

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## Introduction

Cross-linguistic studies have identified that people with fluent and nonfluent aphasia (PWA) present with aberrant patterns of pronominal use. Research data from studies that have quantified the morphological and structural aspects of aphasic spontaneous speech have shown variable pronominal patterns between PWA (Bird et al., 2002; Edwards, 1995; Gurland, Chwat, & Wollner, 1982; Hesketh & Bishop, 1996; Rochon, Saffran, Berndt, & Schwartz, 2000; Ruigendijk, 2002; Ruigendijk & Baauw, 2007; Ruigendijk & Bastiaanse, 2002; Ruigendijk, van Zonneveld, & Bastiaanse, 1999; Saffran, Berndt, & Schwartz, 1989; Wagenaar, Snow, & Prins, 1975; Webster, 1999); and, between PWA and people without aphasia. The differential use of pronominal words in spontaneous aphasic speech has been evidenced in the form of abnormal noun-to-pronoun ratios (e.g. over- or under-production), omissions, inappropriate or incorrect substitutions, and inappropriate reidentification of the contextual antecedent. However, these differential patterns of pronominal use have not been systematically studied to determine why the patterns are produced as such.

Difficulty with pronominal processing has been exposed in on- and off-line experimental designs at the sentence-level (Caplan, Waters, DeDe, Michaud, & Reddy, 2007a; Choy & Thompson, 2005, 2010; de Roo, 2003; Edwards & Varlokosta, 2007; Grodzinsky et al., 1993; Kohn et al., 1997; Love, Nicol, Swinney, Hickok, & Zurif, 1998; Love, Swinney, & Zurif, 2001; Piñango & Burkhardt, 2001; Varlokosta & Edwards, 2003), evidencing broad variations of error patterns of pronominal use. As a result of such confounding error patterns, the current literature maintains a steady disagreement regarding the underlying nature of their difficulty. There are different aspects of pronominal processing which may be selectively impaired and may underpin the difficulty observed in their use. One possibility considers the difficulty as a consequence from a word-class dissociation between open- and closed-class words (Andreewsky & Seron, 1975; Bradley, 1983; Bradley & Garrett, 1983; Bradley, Garrett, & Zurif, 1980; Caramazza & Zurif, 1976; Friederici & Schonle, 1980; Gardner & Zurif, 1975; Garrett, 1975, 1980, 1981; Swinney, Zurif, & Cutler, 1980). Another possibility assumes the difficulty is underpinned by a syntactic processing impairment specific to the coreferential processes required when pronominal words are processed implicitly in context (e.g. sentences), within the sentence boundaries (Caplan et al., 2007a; Choy & Thompson, 2005, 2010; de Roo, 2003; Edwards & Varlokosta, 2007; Grodzinsky et al., 1993; Kohn et al., 1997; Love et al., 1998; Love et al., 2001; Piñango & Burkhardt, 2001; Varlokosta & Edwards, 2003). Still, another possibility assumes the difficulty surfaces when pronouns are introduced into discourse and are processed as explicitly discourse-linked elements, simultaneously with other linguistic processes across

multiple sentences (Avrutin, 2000, 2006; Bos, Dragoy, Avrutin, Iskra, & Bastiaanse, 2014; Peristeri & Tsimpli, 2013). Contrastively, some literature studies have been unable to evidence error patterns of pronoun use in PWA when compared to adults without aphasia (Kimbarow & Brookshire, 1983; Ruigendijk, Vasic, & Avrutin, 2006).

The majority of the literature has focused the investigation of pronominal impairment on people with nonfluent aphasia, as this population characteristically demonstrates difficulty with grammatical aspects of language processing. However, people with fluent aphasia have also demonstrated aberrant use of pronominal words. The difficulty observed in both fluent and nonfluent PWA raises the question of whether there is something uniquely difficult about pronominal processing in the aphasic linguistic system, or if pronominal processing difficulties are secondary to other processing difficulties. Therefore, the overall questions remain as to what degree pronominal processing is impaired in PWA; and, what aspect of pronominal words is difficult to process? This study investigated how PWA process pronouns and reflexives at different levels of communication. Particular emphasis was placed on how differential factors in terms of increased syntactic, thematic, and structural complexities (e.g. reversibility, passivization, pronoun competition) may influence pronominal processing in the aphasic linguistic system. Furthermore, this study aimed to understand if different pronominal feature markers are differentially processed or selectively impaired.

## **Method**

A series of four language experiments were conducted to assess pronominal processing in PWA (13 fluent, seven nonfluent). The experiments investigated: 1) single-word pronoun and reflexive comprehension using a word triad task; 2) pronoun and reflexive comprehension in sentences using a cross-modal sentence-picture matching task; 3) pronoun and reflexive production in sentences using a cross-modal picture description task; 4) pronoun comprehension in discourse using an auditory comprehension task. A generalized linear mixed model (GLMM) (Baayen, Davidson, & Bates, 2008; Gelman, & Hill, 2007) was used to analyze the data collected. The results of pronominal processing at single-word, sentence, and discourse levels from PWA were compared to healthy controls ( $n=10$ ), and then between aphasia type.

## **Results**

The findings from the single-word experiment have shown that gender and number pronominal feature markers are processed with more ease ( $\beta=0.776$ ,  $SE=0.606$ ,  $z\text{-value}=-1.281$ ,  $p<0.200$ ) when compared to person and case feature markers ( $\beta=0.947$ ,  $SE=0.473$ ,  $z\text{-value}=-2.002$ ,  $p<0.045^*$ ) in both fluent and nonfluent PWA. The findings from the sentence comprehension experiment have shown that PWA interpret pronouns similarly to healthy controls when processing pronouns as implicit or non-discourse-linked elements under varying levels of syntactic and thematic complexities ( $\beta=1.117$ ,  $SE=0.668$ ,  $z\text{-value}=1.648$ ,  $p<0.993$ ). Furthermore, the results from the sentence production and discourse comprehension experiments suggest that people with fluent and nonfluent aphasia process pronouns with significantly more

difficulty than healthy controls when processed as discourse-linked elements (sentence production:  $\beta=3.521$ ,  $SE=0.531$ ,  $z\text{-value}=6.626$ ,  $p<0.001^*$ ; discourse comprehension:  $\beta=4.155$ ,  $SE=0.613$ ,  $z\text{-value}=6.780$ ,  $p<0.001^*$ ).

## Discussion

The novel findings from this study have advanced our understanding of pronominal processing in PWA. The findings suggest that the difficulty does not appear to be a result of a pure word-class dissociation between open- and closed-class word processing, nor does the difficulty appear to occur as a global impairment impacting pronominal processing across all levels of communication (e.g. sentences, discourse). Rather, the findings suggest the difficulty is relevant to specific syntactic computations required to build and interpret coreferential links between pronoun referents and contextual antecedents in discourse, whereby pronoun resolution is realized as explicitly discourse-linked processing across multiple sentences.

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